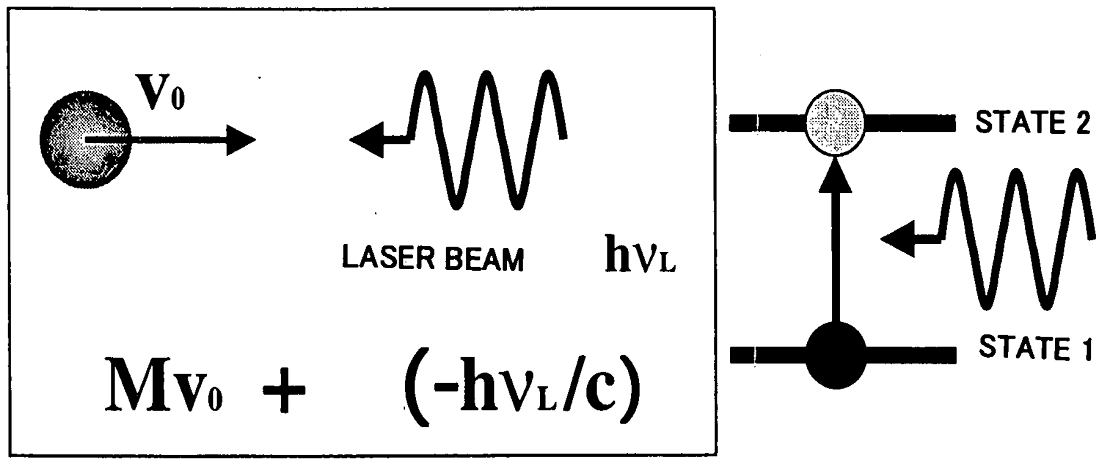
FIG. 1

FORCE ACTS ON NEUTRAL ATOM (SCATTERING FORCE)

·LIGHT ABSORPTION OF ATOM IN MOTION WITH CONSTANT VELOCITY



$$\nu_L = \nu_0 \cdot c/(c+v_0)$$
$$= \nu_0 \cdot \{1 - v_0/(c+v_0)\}$$
$$< \nu_0$$

·LIGHT EMISSION OF ATOM IN MOTION WITH CONSTANT VELOCITY

$$F = \Delta P/(2\tau) = M(v_0 - v_1)/(2\tau)$$
$$= h\nu_L/(2\tau c)$$

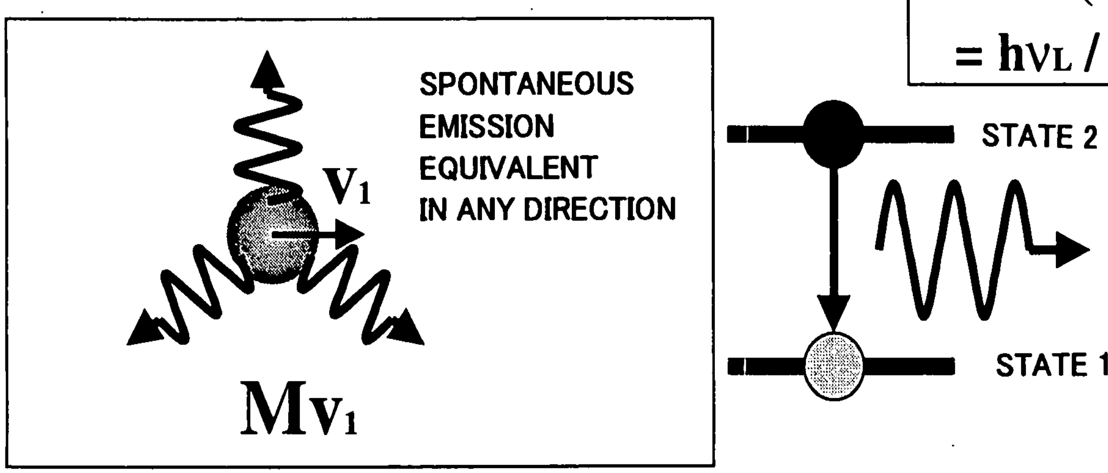


FIG. 2

STOP TIME

$$t = 2N\tau = 2 \cdot 11476 \cdot 5.524861878\text{ns} = 126.8\ \mu\text{s}$$

NATURAL WIDTH

$$\Delta\nu\ (=\gamma) = 1/(2\pi\tau) = 1/(2\text{x}3.141592654\text{x}5.52486\text{ns}) = 28.807054\text{MHz}$$

Doppler COOLING TEMPERATURE $kTD = h/(2\pi) \cdot \gamma = 6.6260755\text{x}10\text{-}34\ /2/\ 3.141592654/\ (2\text{x}3.141592654\text{x}5.52\text{ns}) = 220.227\mu\text{K}$

FIG. 3

Doppler WIDTH

Δvd= 2v0 ((2kB T/Mc2) ln2)1/2 =2 · 1.18735651x1015 · (2x1.380658x10-23xT/(27.976957 · 1.6605402x10-27x2.99792458x108x2.99792458x108) · ln2)1/2 = 160.7815759·T1/2 MHz

IN GASEOUS MOLECULE IN THERMAL EQUILIBRIUM, ATOMS EXHIBIT IRREGULAR Brownian MOVEMENT, EACH ATOM POSSESSES SLIGHTLY DIFFERENT RESONANCE FREQUENCY FROM ONE ANOTHER, AND POSSESSES NATURAL WIDTH IN EACH ATOM.

ACCORDINGLY, AS IN CASE OF GASEOUS MOLECULE, ENVELOPE IN SPECTRAL DISTRIBUTION OF SPONTANEOUS EMISSION REFLECTS ON DISPERSION IN CENTER FREQUENCY OF EACH ATOM. SUCH BROADENING IS CALLED BY NAME OF INHOMOGENEOUS BROADENING.

Doppler WIDTH AT MELTING TEMPERATURE 6045.9MHz = 6.0459 GHz

FIG. 4(a)

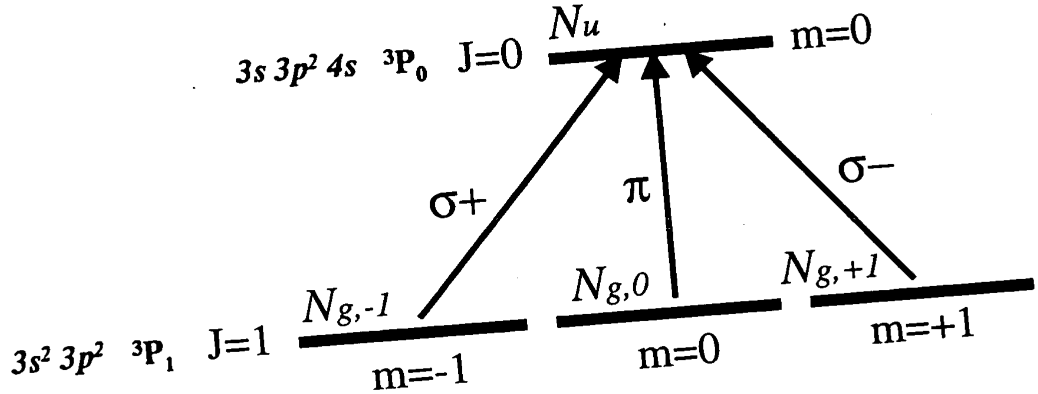


FIG. 4(b)

$$\frac{dN_u}{dt} = W_{\sigma+} + W_{\pi} + W_{\sigma-} - \frac{N_u}{\tau}$$

$$\frac{dN_{g,-1}}{dt} = -W_{\sigma+} + \frac{N_u}{3\tau}$$

$$\frac{dN_{g,0}}{dt} = -W_{\pi} + \frac{N_u}{3\tau}$$

$$\frac{dN_{g,+1}}{dt} = -W_{\sigma-} + \frac{N_u}{3\tau}$$

FIG. 4(c)

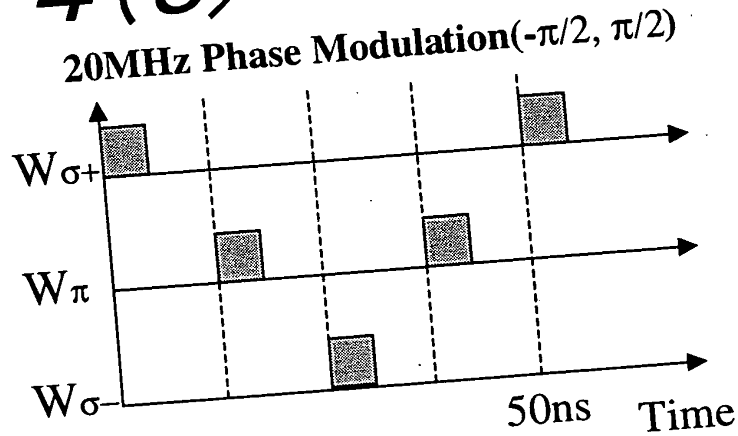


FIG. 5

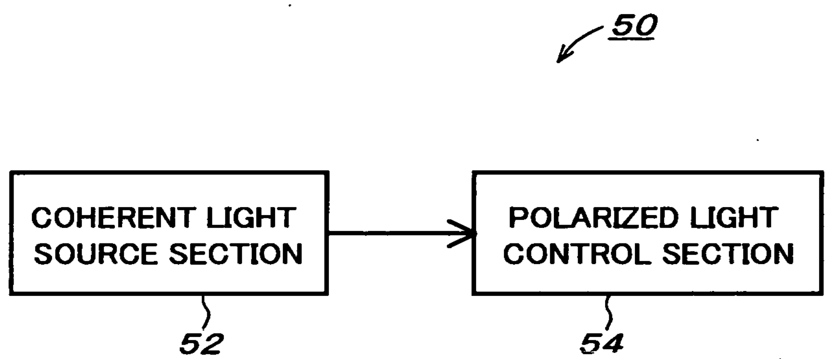

50
COHERENT LIGHT SOURCE SECTION
POLARIZED LIGHT CONTROL SECTION
52
54

FIG. 6

BIREFRINGENCE CRYSTAL

n_o : REFRACTIVE INDEX IN ORDINARY RAY

n_e : REFRACTIVE INDEX IN EXTRAORDINARY RAY

WHERE $n_o < n_e$ (PHASE DELAYS IN n_e–AXIS)

$$\Phi = 2\pi (n_o - n_e) d/\lambda$$

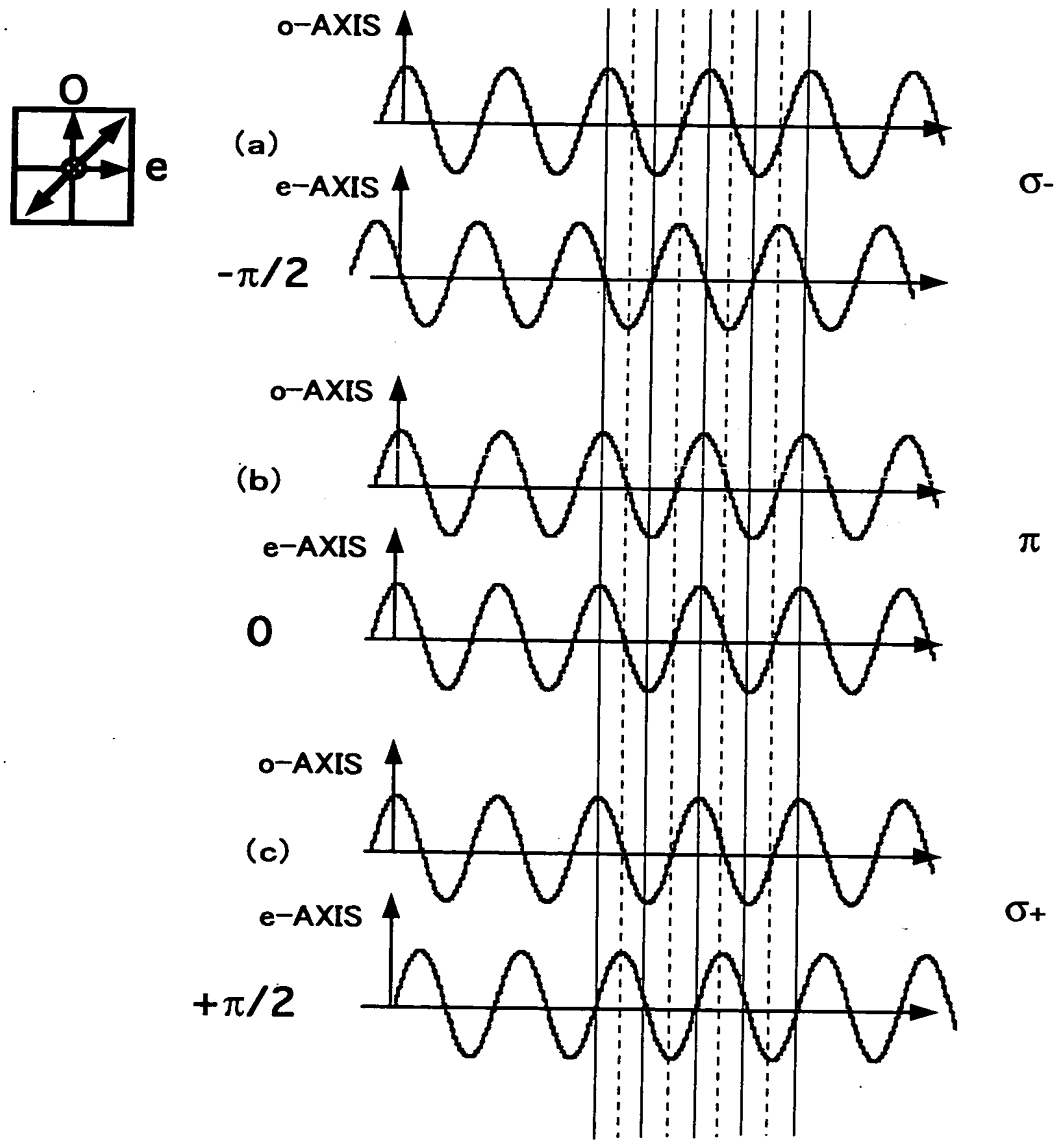
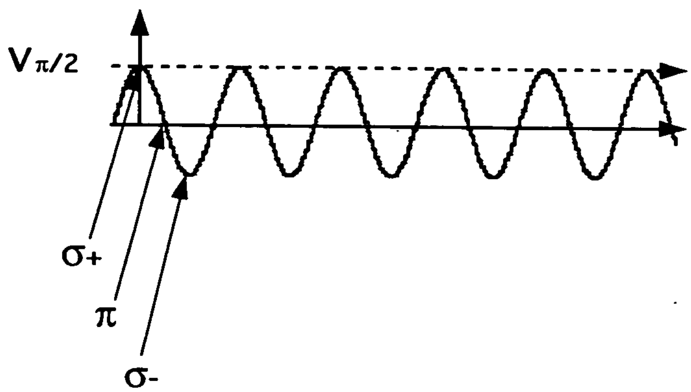


FIG. 7

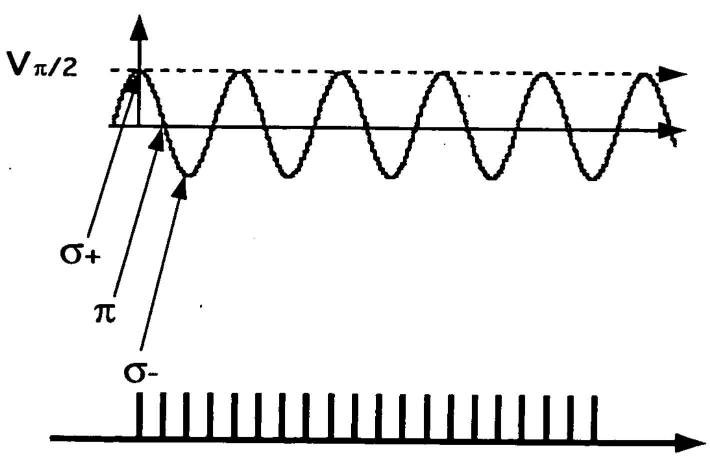


TIME REQUIRED FOR ABSORPTION – EMISSION OF ONE PHOTON : $2\tau = 11\text{ns}$ ($\tau = 5.5\text{ns}$)

↓

IT IS EFFICIENT WHEN NEXT PHOTON STRIKES AFTER 11 ns

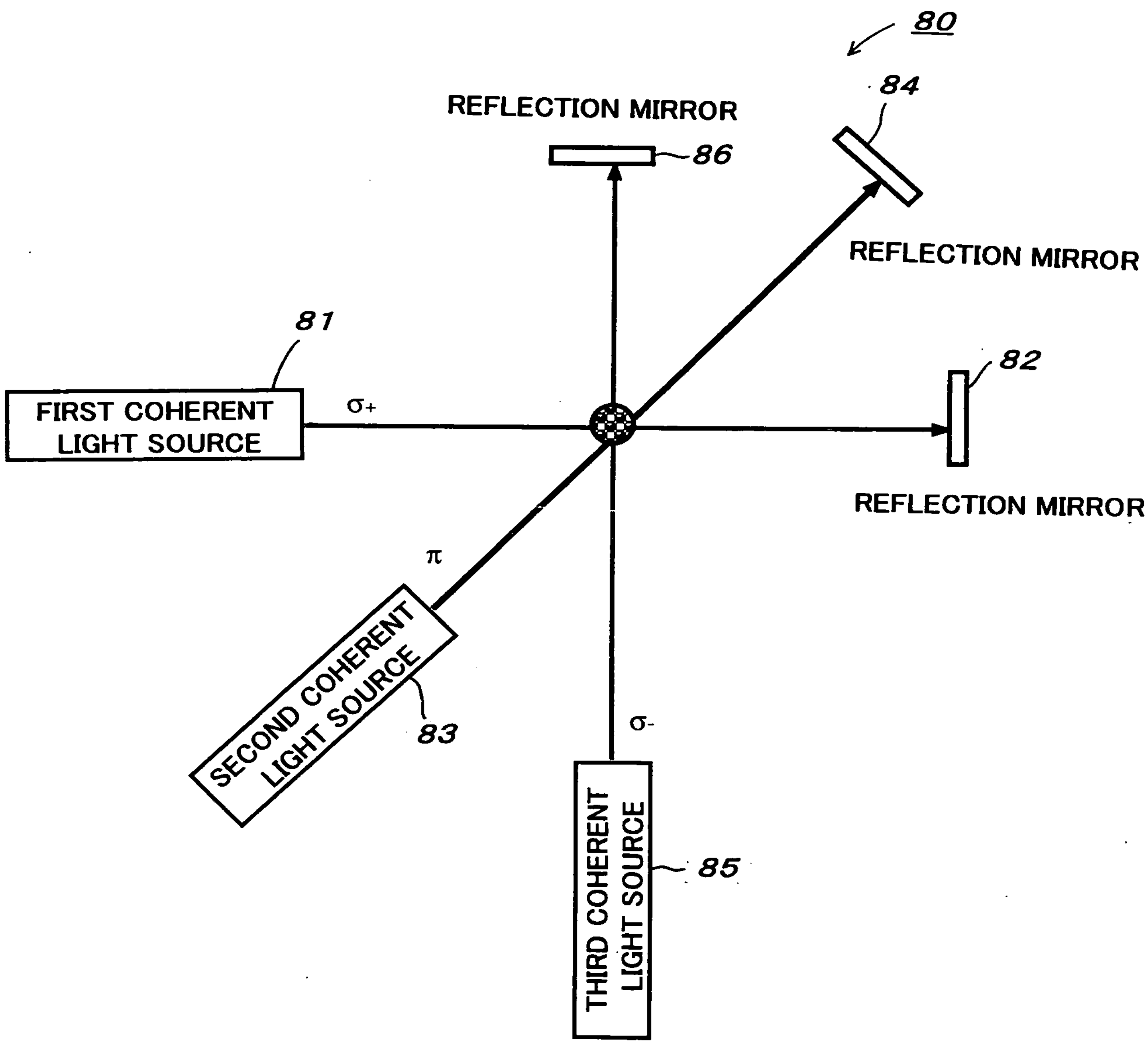
PERIOD $11\text{ns} \times 4 = 44\text{ns}$ -> FREQUENCY IN PHASE MODULATOR $fm < 22.7\text{MHz}$



HIGH REPETITIVE LASER 4 fm

FIG. 8(a)

POLARIZED LIGHT CONTROL BY THREE COHERENT LIGHT SOURCE DEVICES



NO SIMULTANEOUS EMISSION

COHERENT EFFECT APPEARS SO THAT EFFICIENT COOLING CANNOT BE MADE

FIG. 8(b)

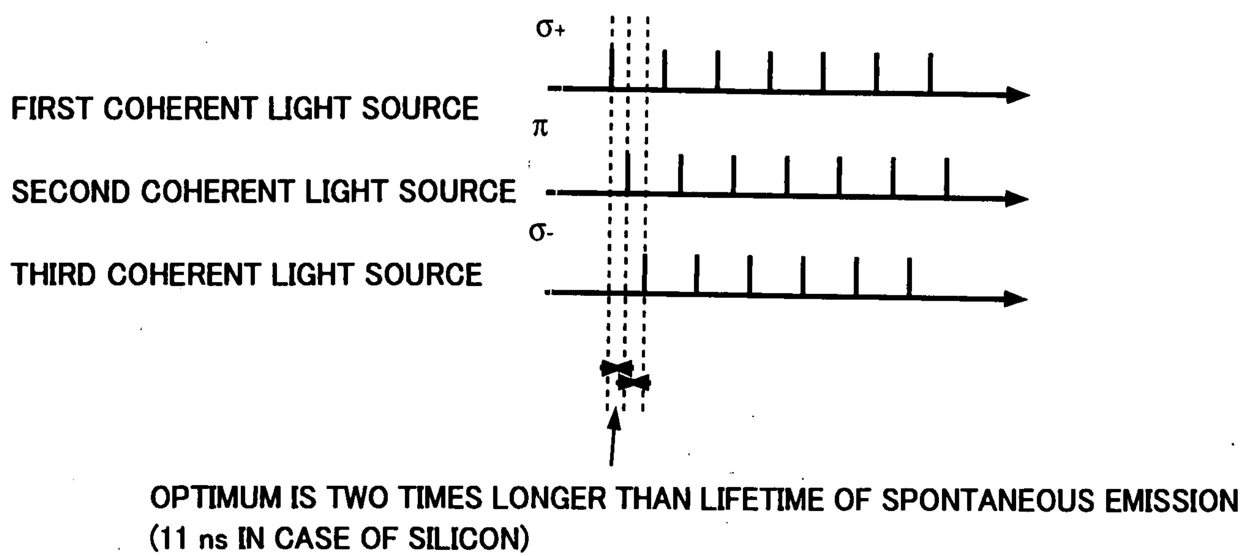
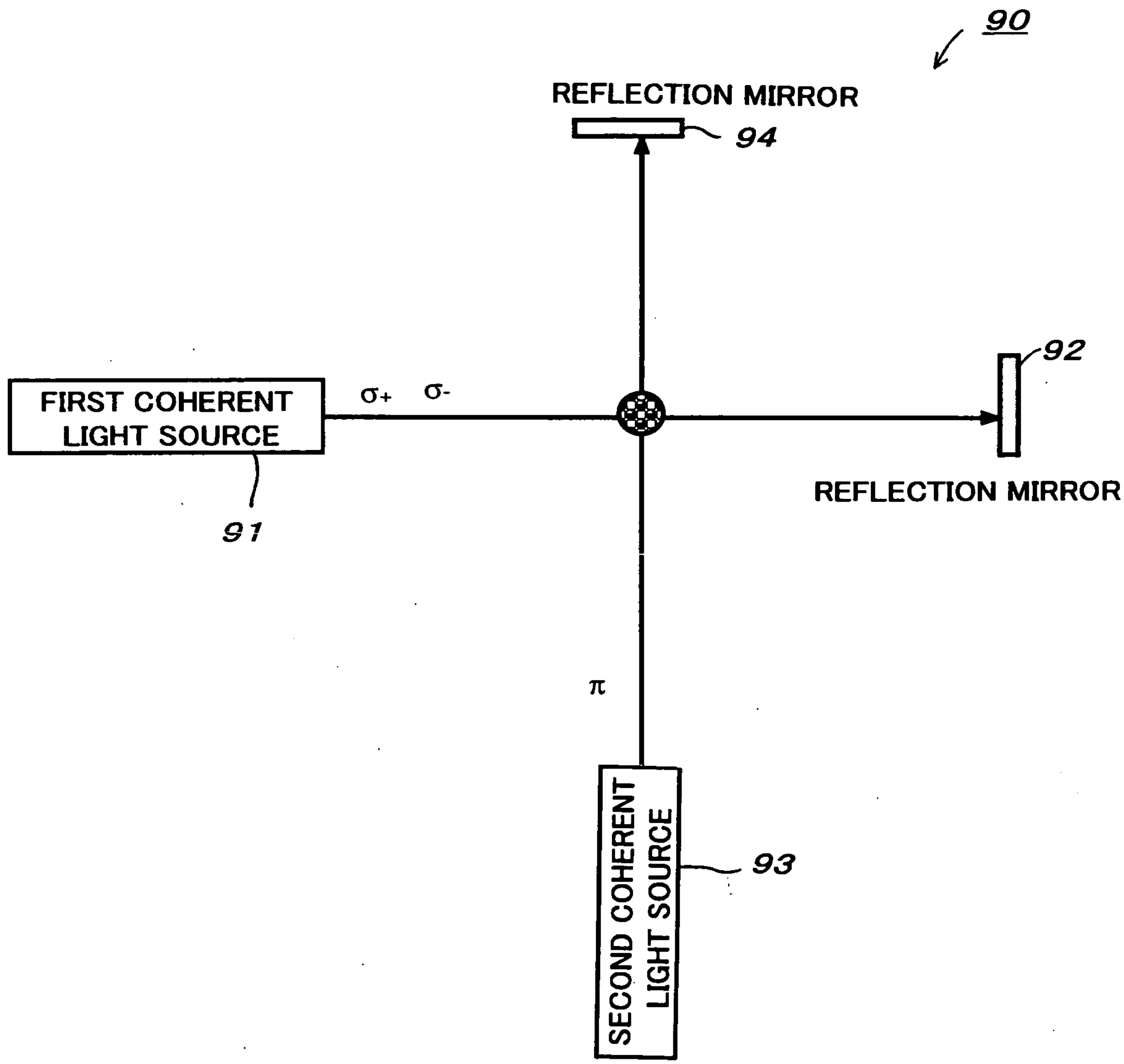

σ+
FIRST COHERENT LIGHT SOURCE
π
SECOND COHERENT LIGHT SOURCE
σ-
THIRD COHERENT LIGHT SOURCE
OPTIMUM IS TWO TIMES LONGER THAN LIFETIME OF SPONTANEOUS EMISSION
(11 ns IN CASE OF SILICON)

FIG. 9(a)

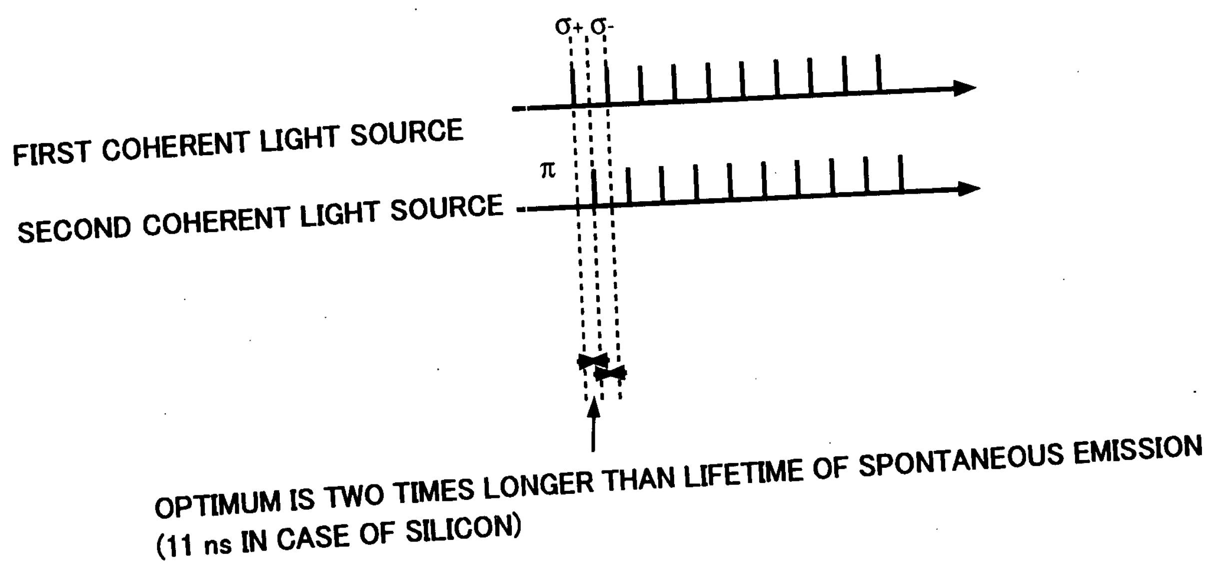
POLARIZED LIGHT CONTROL BY TWO COHERENT LIGHT SOURCE DEVICES



NO SIMULTANEOUS EMISSION

COHERENT EFFECT APPEARS SO THAT EFFICIENT COOLING CANNOT BE MADE

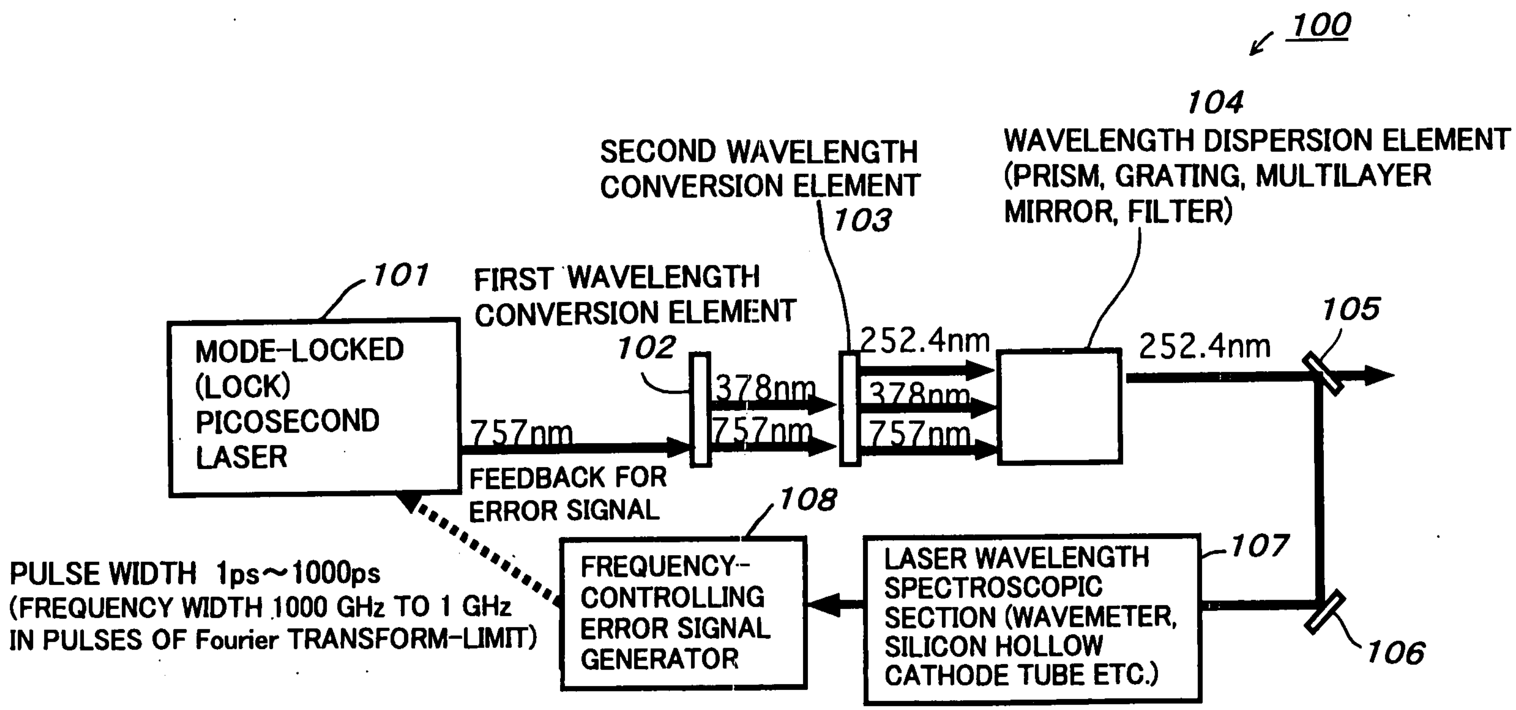
FIG. 9(b)



σ+ σ-
FIRST COHERENT LIGHT SOURCE
π
SECOND COHERENT LIGHT SOURCE
OPTIMUM IS TWO TIMES LONGER THAN LIFETIME OF SPONTANEOUS EMISSION
(11 ns IN CASE OF SILICON)

FIG. 10

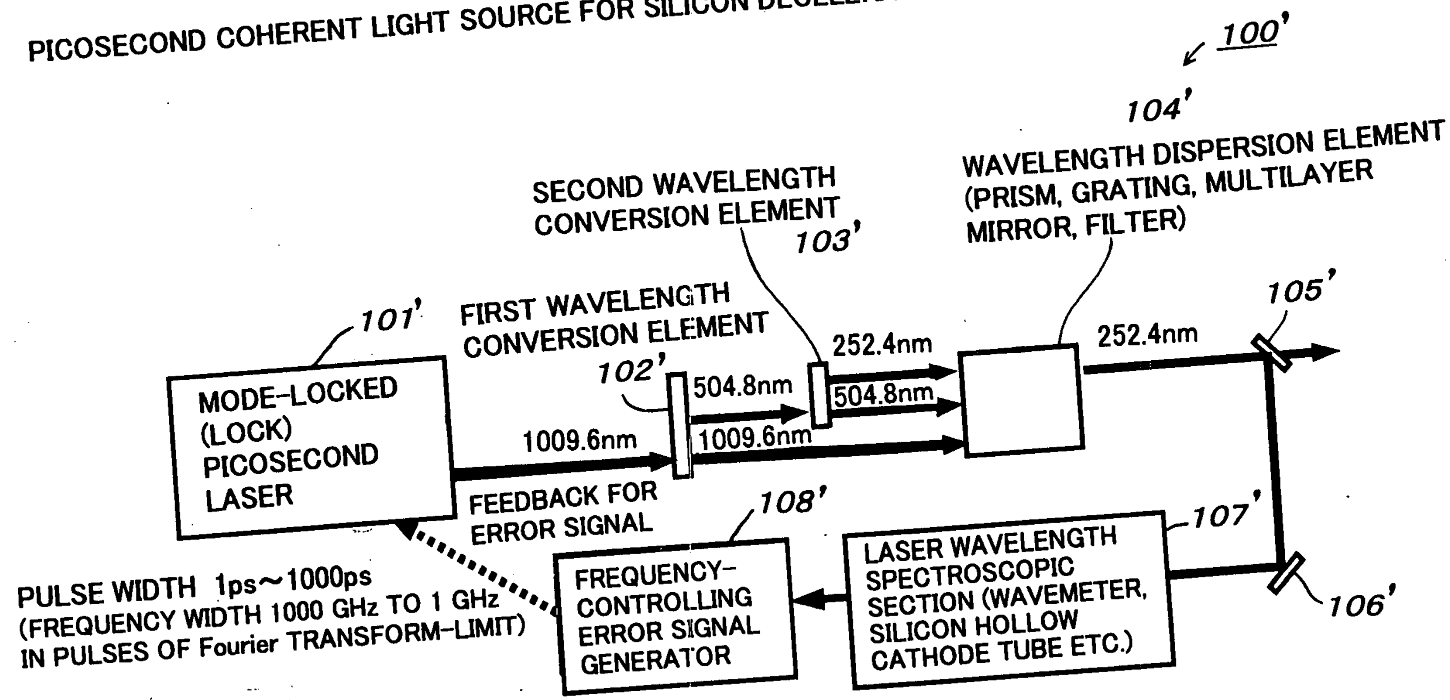
PICOSECOND COHERENT LIGHT SOURCE FOR SILICON DECELERATION: 252.4 nm WAVELENGTH



378 nm CORRESPOND TO SECOND HARMONICS OF 757 nm,
AND 252.4 nm CORRESPOND TO THIRD HARMONICS OF 757 nm

FIG. 11

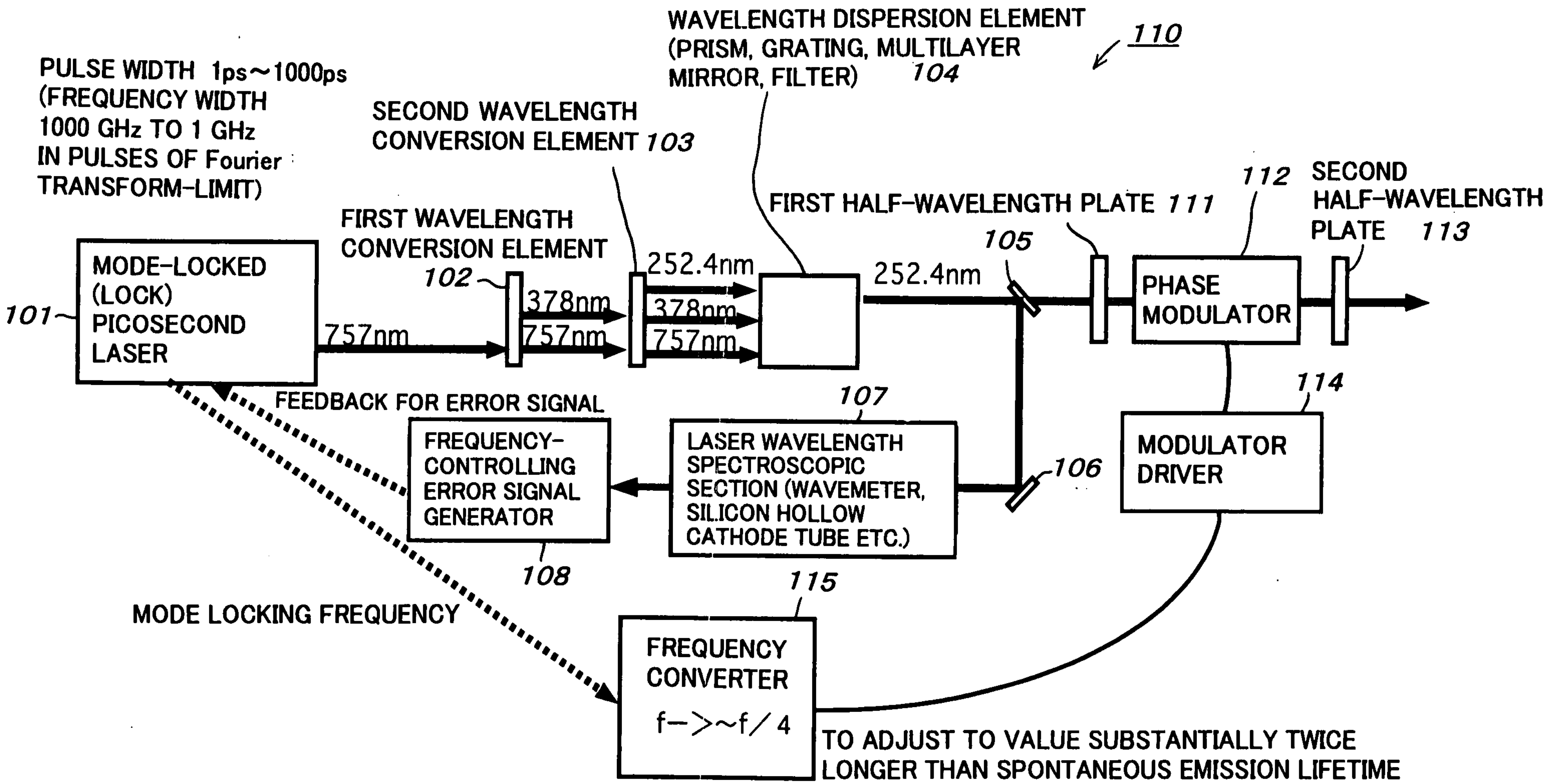
PICOSECOND COHERENT LIGHT SOURCE FOR SILICON DECELERATION: 252.4 nm WAVELENGTH



504.8 nm CORRESPOND TO SECOND HARMONICS OF 1009.6 nm,
AND 252.4 nm CORRESPOND TO SECOND HARMONICS OF 504.8 nm

FIG. 12

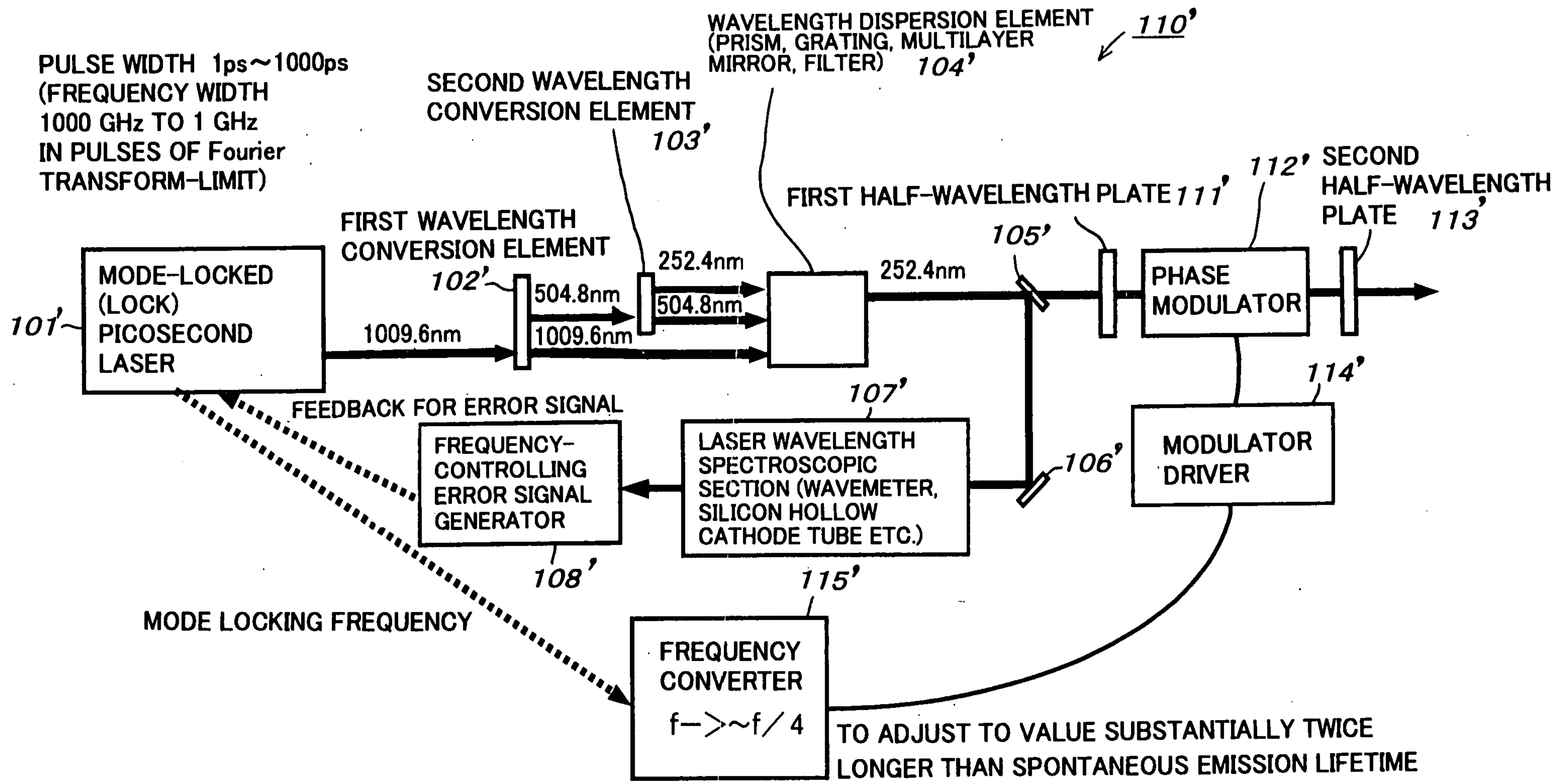
PICOSECOND COHERENT LIGHT SOURCE FOR SILICON DECELERATION TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 252.4 nm WAVELENGTH



378 nm CORRESPOND TO SECOND HARMONICS OF 757 nm, AND 252.4 nm CORRESPOND TO THIRD HARMONICS OF 757 nm

FIG. 13

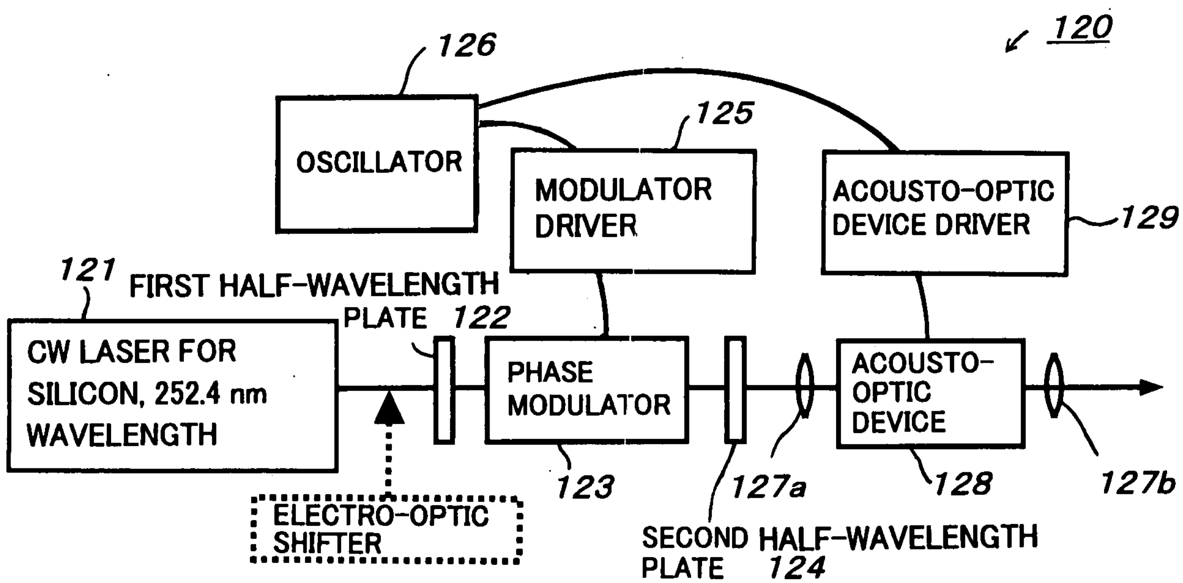
PICOSECOND COHERENT LIGHT SOURCE FOR SILICON DECELERATION TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 252.4 nm WAVELENGTH



504.8 nm CORRESPOND TO SECOND HARMONICS OF 1009.6 nm,
AND 252.4 nm CORRESPOND TO SECOND HARMONICS OF 504.8 nm

FIG. 14

CW COHERENT LIGHT SOURCE FOR SILICON DECELERATION/COOLING TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 252.4 nm WAVELENGTH

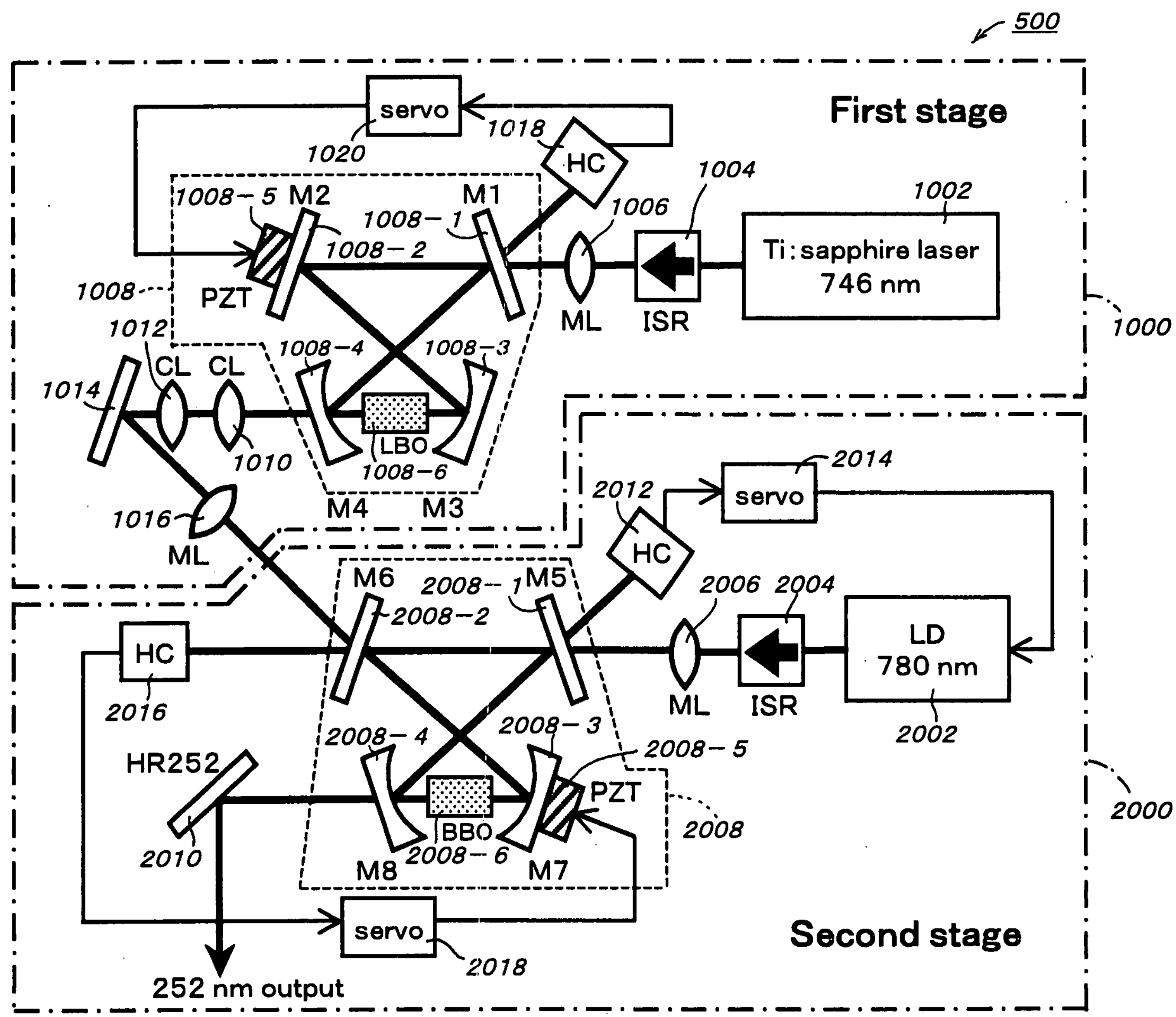


SILICON DECELERATION: FREQUENCY IS CHANGED TIME-VARYINGLY BY USE OF ACOUSTO-OPTIC DEVICE (CHIRPED COOLING)

SILICON COOLING: ACOUSTO-OPTIC DEVICE HAS EFFECT FOR SEPARATING POLARIZED LIGHT AND ADVANTAGEOUS FOR OPTIMIZING FREQUENCY

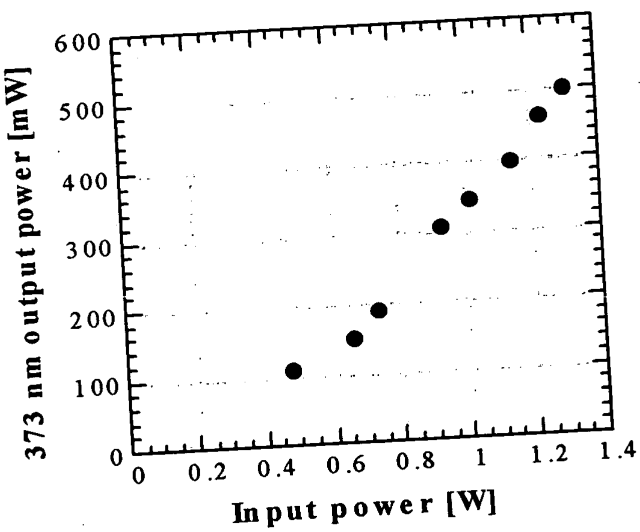
THERE IS CASE EFFECTIVE FOR CHIRPED COOLING BY INCREASING FREQUENCY SHIFT AMOUNT WITH ADDITION OF ELECTRO-OPTIC SHIFTER (EO SHIFTER)

FIG. 15



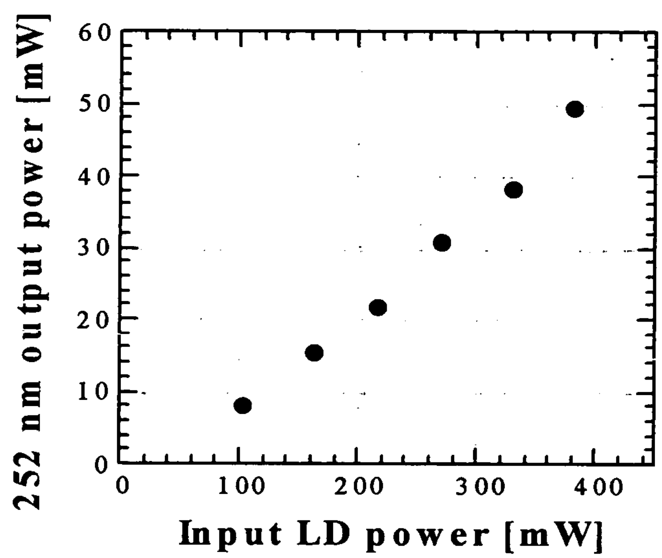
500
First stage
Second stage
Ti:sapphire laser
746 nm
LD
780 nm
servo
HC
ISR
ML
CL
PZT
LBO
BBO
M1
M2
M3
M4
M5
M6
M7
M8
HR252
252 nm output
1000
1002
1004
1006
1008
1008-1
1008-2
1008-3
1008-4
1008-5
1008-6
1010
1012
1014
1016
1018
1020
2000
2002
2004
2006
2008
2008-1
2008-2
2008-3
2008-4
2008-5
2008-6
2010
2012
2014
2016
2018

FIG. 16



600
500
400
300
200
100
0
373 nm output power [mW]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Input power [W]

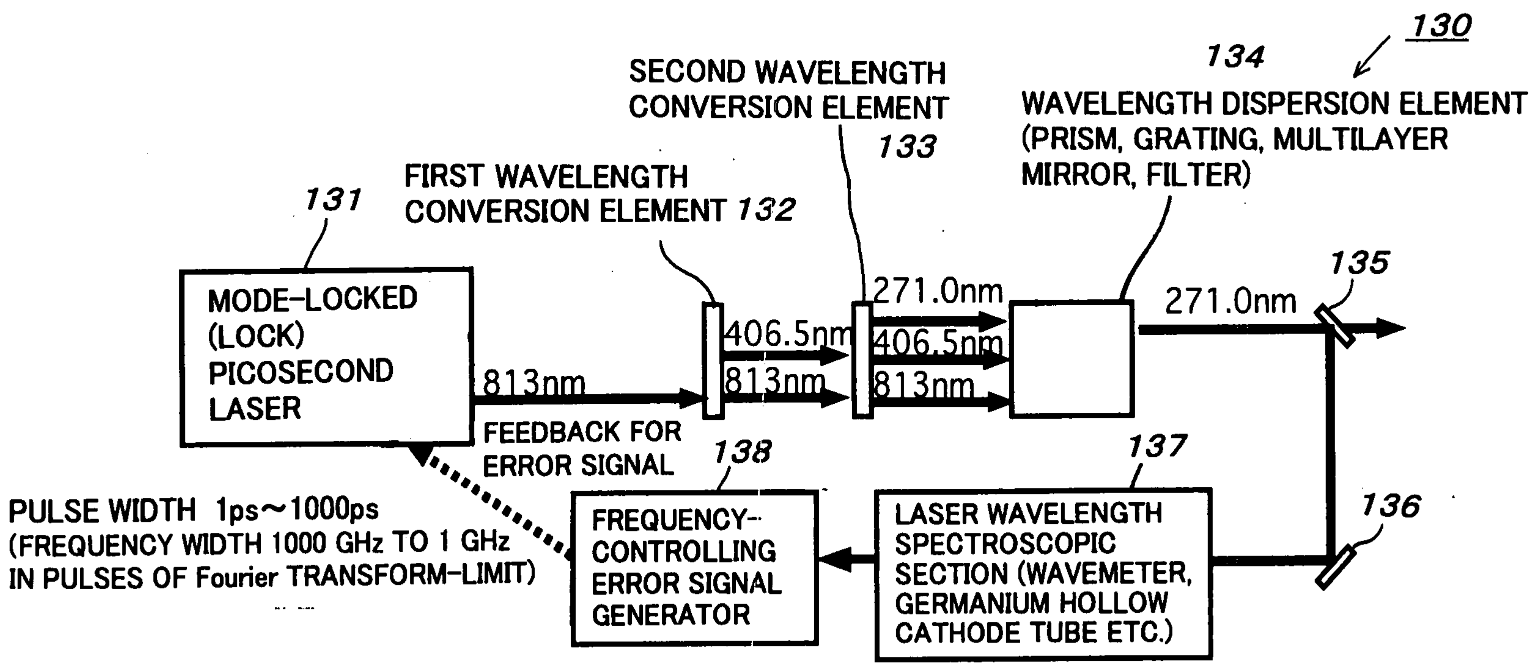
FIG. 17



252 nm output power [mW]
60
50
40
30
20
10
0
0
100
200
300
400
Input LD power [mW]

FIG. 18

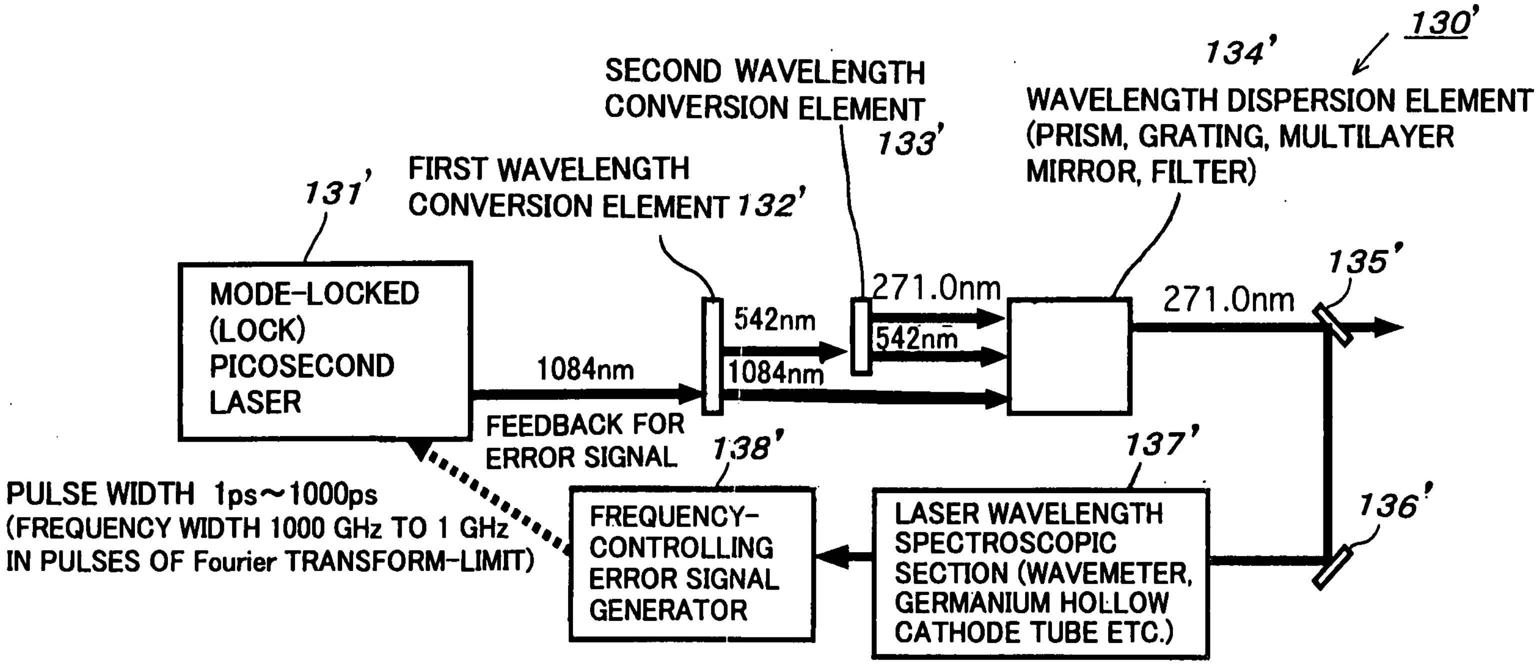
PICOSECOND COHERENT LIGHT SOURCE FOR GERMANIUM DECELERATION: 271 nm WAVELENGTH



406.5 nm CORRESPOND TO SECOND HARMONICS OF 813 nm, AND 271 nm CORRESPOND TO THIRD HARMONICS OF 813 nm

FIG. 19

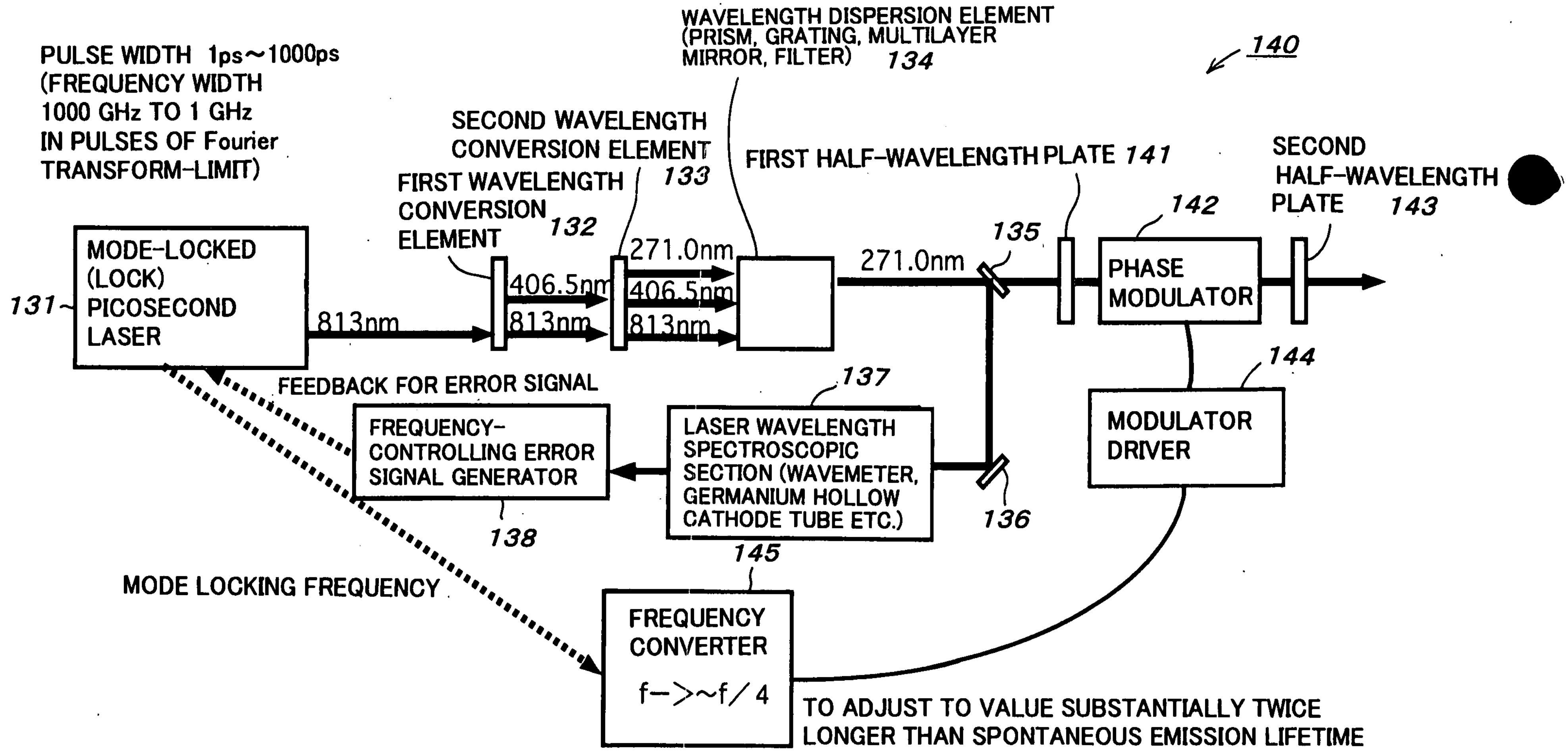
PICOSECOND COHERENT LIGHT SOURCE FOR GERMANIUM DECELERATION: 271 nm WAVELENGTH



542 nm CORRESPOND TO SECOND HARMONICS OF 1084 nm, AND 271 nm CORRESPOND TO SECOND HARMONICS OF 542 nm

FIG. 20

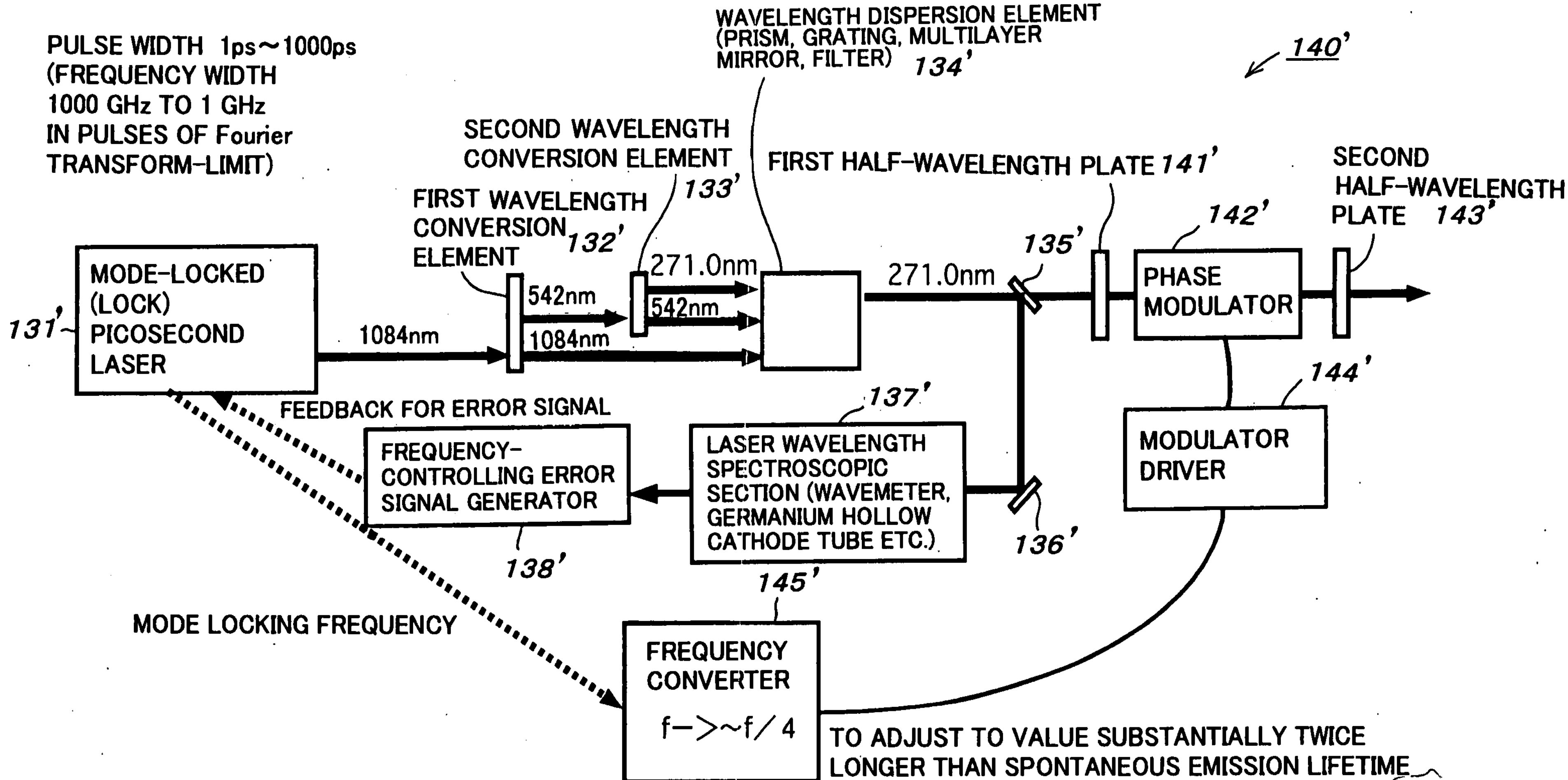
PICOSECOND COHERENT LIGHT SOURCE FOR GERMANIUM DECELERATION TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 271 nm WAVELENGTH



406.5 nm CORRESPOND TO SECOND HARMONICS OF 813 nm, AND 271 nm CORRESPOND TO THIRD HARMONICS OF 813 nm.

FIG. 21

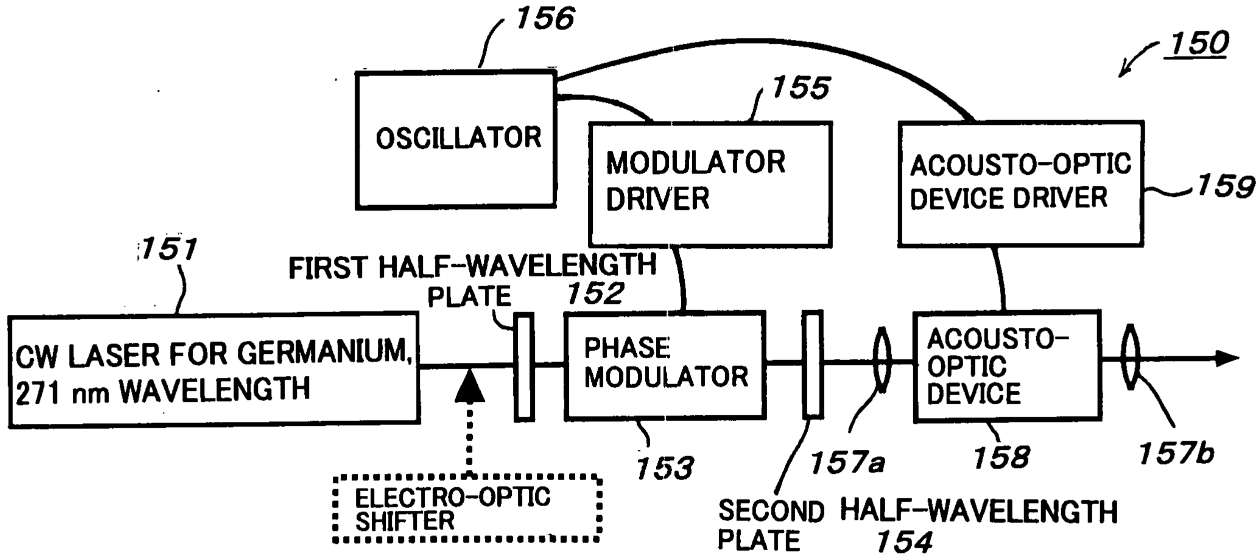
PICOSECOND COHERENT LIGHT SOURCE FOR GERMANIUM DECELERATION TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 271 nm WAVELENGTH



542 nm CORRESPOND TO SECOND HARMONICS OF 1084 nm, AND 271 nm CORRESPOND TO SECOND HARMONICS OF 542 nm

FIG. 22

CW COHERENT LIGHT SOURCE FOR GERMANIUM DECELERATION/COOLING TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 271 nm WAVELENGTH



GERMANIUM DECELERATION: FREQUENCY IS CHANGED TIME-VARYINGLY BY USE OF ACOUSTO-OPTIC DEVICE (CHIRPED COOLING)

GERMANIUM COOLING: ACOUSTO-OPTIC DEVICE HAS EFFECT FOR SEPARATING POLARIZED LIGHT AND ADVANTAGEOUS FOR OPTIMIZING FREQUENCY

THERE IS CASE EFFECTIVE FOR CHIRPED COOLING BY INCREASING FREQUENCY SHIFT AMOUNT WITH ADDITION OF ELECTRO-OPTIC SHIFTER (EO SHIFTER)